GEOLOGICAL SURVEY OF PENNSYLVANIA.

J. P. LESLEY, STATE GEOLOGIST.

SUMMARY OF THE REPORTS

OF THE

STATE GEOLOGIST,

FROM

1874 TO 1887.

Published for the information of the Members of the Legislature of 1887.

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1887.

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* Mr. Charles A. Ashburner, Geologist in Charge, has been authorized to furnish to the members of the Legislature whatever information they may desire in regard to the Survey. Mr. Ashburner can be seen in Harrisburg, when desired, but all communications to him should be addressed 907 Walnut street, Philadelphia.

SUMMARY

OF THE

REPORTS OF THE STATE GEOLOGIST

From 1874 to 1887.

In 1874 the survey was commenced in Venango and Butler, in Clearfield and Jefferson, in Mifflin and Huntingdon, in York and Adams, and in Lehigh county.

In 1875 it was continued in those counties, and was commenced in Greene, Washington, and Allegheny, in Cambria and Blair, and in Tioga and Bradford. A special survey of parts of Clinton was also made.

In 1876 the survey of the oil region was made to include parts of Warren and Crawford, Clarion and Armstrong. The rest of Allegheny was surveyed; half of Westmoreland and Fayette; all Beaver; half of Butler; all Somerset, Potter, and part of Snyder; and the survey of McKean was commenced. The Lehigh work was extended into Northampton and Berks; the York and Adams work into Franklin and Cumberland.

In 1877 the survey of the oil region and that of McKean were continued; Westmoreland, Fayette, and Butler were finished; Lawrence, Indiana, Lycoming, and Sullivan surveyed; the Blair county topographical survey extended; the South mountain topographical survey continued; the Northampton mountain and valley topographical survey extended into Berks; the survey of Juniata commenced; the topographical survey of the Seven mountains in Snyder commenced; the survey of Elk, Cameron and Lancaster county commenced, and the outcrops of southern Bucks and Montgomery mapped and specimens collected.

In 1878 the survey of the oil region was continued; Mercer, Clarion and Armstrong surveyed; McKean completed; Potter revised; Juniata revised and Perry surveyed; mapping in Blair finished; mapping of the Seven mountains continued; mapping of the South mountains continued; mapping of the Reading mountains continued; Lancaster completed; Southern Bucks and Montgomery mapped; and the museum arranged and catalogued.

In 1879 the survey of the oil regions was continued; Crawford, Erie, Jefferson, and Clinton were surveyed; the Elk and Cameron survey was extended into Forest, and the work in all three counties completed; the Franklin county valley was surveyed; the South mountain topography continued; the Reading mountain survey extended westward; the survey of the Philadelphia belt extended into Delaware county; and Chester county surveyed.

In 1880 the survey of the oil region was continued; the Coal Flora (collected, studied, described, and figured by Mr. Lesquereux since 1874) was published; the descriptions of the coal plants of Greene county were published; the subject of Waste in Anthracite Coal was studied; Susquehanna and Wayne county were surveyed; the South mountain topography was continued; the Cumberland county valley was surveyed; and the study of anthracite geology and mining methods commenced.

In 1881 the survey of the oil region was continued; Warren was surveyed; Pike and Monroe, and part of Carbon were surveyed; a special palæontological survey of Perry and Juniata was commenced; and a systematic mine and surface survey of all the anthracite coal-fields was organized.

In 1882 the Anthracite survey was carried forward; Centre, Dauphin, Lebanon, Luzerne, Lackawanna, Columbia, Montour and Northumberland counties were surveyed; the Perry county palæontology continued; the third and last volume of the Coal Flora published; the Report on

Methods of Coal Mining completed; and the first sheets of the Anthracite Survey published. A special survey along the Lehigh river was commenced.

In 1883 a special survey of the Monongahela river collieries was made; the Clearfield county coal-fields were re-surveyed; Huntingdon county was finished; the roofing-slate belt in Northampton, Lehigh, and Berks was surveyed; the glacial moraine was traced across the State; the survey of the Anthracite fields was continued, additional sheets published, and a special topographical survey of the Wyoming coal field commenced. The Hand Atlas of counties was prepared for publication.

In 1884 the Anthracite surveys were continued, and some unfinished work in other parts of the State undertaken.

In 1885 there remained still unaccomplished a necessary revision of parts of Forest, Tioga, Bradford, Union and Snyder, and of the whole of Juniata; a survey of the Pinegrove-Orwigsburg valley; some special local surveys in Cumberland, Dauphin, Lebanon and Bucks; a systematic survey of the Mesozoic country in Berks, Montgomery and Bucks, and some important local surveys in Chester and Delaware, before the final preparation of the remaining volumes of county reports could be published. If the usual annual appropriation for the Survey had been continued all this would have been accomplished prior to 1885 without interfering with the progress of the Anthracite surveys.

But the appropriations made in 1883 and 1885 were reduced to one-half, and a new survey of the oil, gas, and coal-fields of Western Pennsylvania ordered by the Legislature of 1885. A new disposition of the force of the Survey had to be made, the proposed local work in the different counties named above postponed; and operations in the Anthracite fields restricted within narrower limits.

It is impossible to carry on a great work usefully without sufficient money. Skilled experts must be properly paid. Necessary expenses must be met. The most conscientious

economy has its limits fixed by the nature of the undertaking. Personal zeal and a self-sacrificing love for and pride in good work of a noble kind can be carried to a certain height, and no higher. The State can do its geology, like the rest of its doings, only on business principles. What costs little is never good for much, and the utility of a geological survey to the Commonwealth will be exactly measured by the amount of time and money spent upon it. Fifty thousand dollars is not a large sum for a great State to spend annually in exploring its mineral resources, in making them generally known, and in obtaining or endeavoring to obtain explanations of natural facts which puzzle the best intellects. But the appropriation of 1885 only permitted an annual expenditure of twenty-five thouand dollars a year. Continual investigation is part of the price of human progress and national prosperity. The Geological Survey is only one kind of investigation among many others carried on by the people of Pennsylvania; but it is as necessary and as important as any other kind; and, being systematic, and based upon a store of real knowledge, is one of the surest and one of the cheapest kinds. Pennsylvania is the only State in the Union which has shown an enlightened appreciation of the value of a thorough geological survey by appropriating adequate sums of money for its accomplishment.

The cost of the Survey was limited by the following appropriations:

Act of May 14, 1874,	$105,000
Act of May 13, 1876,	65,000
Act of April 18, 1877,	100,000
Act of June 11, 1879,	50,000
Act of May 26, 1881,	125,000
Act of June 28, 1883,	50,000
Act of July 3, 1885,	50,000
Total appropriation for 13 years,	$545,000

From May, 1874, to July, 1885, there was appropriated

for the work of the Survey, $495,000, permitting an average yearly expenditure, for 11 years, of $45,000.*

The expenses for the first six months of 1885, ($10,194 45,) were met by the appropriation of June 28, 1883; and for the second six months ($14,489 30) by the appropriation of July 3, 1885.

The total expenditure for 1885 was $24,683 75.

Balance in hand January 1, 1886, to meet the expenses of 1886, and the six months of 1887, $35,510 70.

The expenditures in 1886 were $23,463 30.

Balance in hand January 1, 1887, to meet the expenses of the survey to July 1, $12,047 40.

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*The amounts disbursed by the State Geologist, under the direction of the Board of Commissioners, have been accounted for by monthly detail vouchers, audited and approved by the Board, and deposited with the Auditor General of the State.

Persons engaged in the Survey and the length of time of their active connection with it previous to January 1, 1886.

	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Adachi, Jinzoo,	..	..	..	..	..	..	..	..	..	..	×	×	×
Aquirré, A. A., (1)	..	..	×	×	..	..	..	..	..	..	..	..	..
Albright, C. E.,	..	..	..	..	..	..	..	×	..	..	..	..	..
Albright, H. F.,	..	..	..	..	..	..	..	..	..	..	..	×	×
*Allen, Charles,	×	×	×	×	×	×	×	..	..	..	..	..	..
Ames, C. W.,	..	..	..	×	×	×	..	..	..	..	..	..	..
*Ashburner, Charles A.,	×	×	×	×	×	×	×	×	×	×	×	×	×
Beecher, C. E., (2)	..	..	..	..	..	..	..	..	×	..	..	..	.
Berlin, A. P.,	..	..	×	×	×	×	..	×	×	×	..	..	..
Billin, C. E.,	×	×	×	×	×	×	..	..	..	..	..	..	..
Branner, J. C.,	..	..	..	..	..	..	..	..	..	×	×	×	..
*Carll, J. F.,	×	×	×	×	×	×	×	×	×	×	..	×	×
*Chance, H. M.,	×	×	×	×	×	×	×	×	×	×	×	..	..
Clark, Ellis, Jr.,	×	×	×	..	..	..	..	..	..	..	..	..	..
Claghorn, R. C.,	..	..	..	..	..	..	..	..	..	..	×	×	..
*Claypole, E. W.,	..	..	..	..	..	..	..	×	×	×	.	..	..
Carraher, M.,	..	..	..	..	×	×	×	×	×	×	×	×	×
Chapman, M.,	..	..	..	..	..	..	×	×	..	..	..	..	..
Christian, G. H.,	×	×	..	..	..	..	..	..	.	..	..	..	..
Dager, J. H.,	..	..	×	..	..	..	..	..	..	..	..	..	..
*Dewees, J. H.,	×	×	×	×	×	×	..	..	..	..	..	..	..
*d'Invilliers, E. V.,	..	..	..	..	..	×	×	×	×	×	×	×	×
Eakins, L. G.,	..	..	..	..	..	..	..	×	..	..	..	..	..
Edwards, J. W.,	×	×	×	..	..	..	..	..	..	..	..	..	..
*Ewing, A. L., (3)	..	..	..	..	..	..	..	..	..	×	..	..	..
Fagen, H. J.,	×	×	..	..	..	..	..	..	..	..	..	..	..
Fellows, W. A.,	..	..	..	..	×	×	..	..	..	..	..	..	..
Flick, W. J.,	..	..	..	..	..	..	..	×	..	..	..	..	..
Ford, S. A.,	..	×	..	..	..	..	..	..	..	..	..	..	..
Forman, F. W.,	×	×	×	×	×	×	×	×	×	×	..	..	..
*Frazer, Persifor,	×	×	×	×	×	×	×	..	..	..	..	..	..
Fuller, J. T.,	..	..	..	..	..	×	..	..	..	..	..	..	..
*Genth, F. A.,	×	×	×	×	×	×	×	×	×	..	..	..	..
Griffith, William,	..	..	..	..	..	..	..	..	..	×	..	..	..
Halberstadt, B.,	..	..	..	..	..	..	..	×	×	×	×	×	×
Haldeman, B. F.,	..	..	..	..	..	..	..	..	×	..	..	..	..
Hale, A.,	×	×	×	×	×	.	..	..	..	..	..	..	..
*Hall, C. E.,	..	×	×	×	×	×	×	×	×	..	..	..	..
*Harden, Edward B.,	×	×	×	×	×	×	×	×	×	×	×	×	×
Harden, O. B.,	..	×	×	×	×	×	×	×	×	×	×	×	×
Hartranft, S. S.,	..	..	..	..	×	×	..	..	..	..	..	..	.
Hartshorne, J.,	..	..	×	×	×	..	..	..	..	..	..	..	..
Hatch, F. A.,	×	×	..	.	..	..	..	..	..	..	..	..	..
*Hill, F. A.,	..	..	..	..	..	..	..	×	×	×	×	×	×
*Hunt, T. S., (4)	..	×	..	..	..	..	..	..	..	..	..	..	..
Kada, Teichii,	..	..	..	..	..	..	..	..	×	×	..	..	..
Lehman, A. E.,	×	×	×	×	×	×	×	×	×	×	×	..	..
Lehman, G. M.,	..	..	..	..	..	..	..	..	..	..	×	×	×
Lesley, Joseph, (5)	..	..	..	..	..	..	×	..	..	..	..	..	..
*Lesley, J. P.,	×	×	×	×	×	×	×	×	×	×	×	×	×
*Lesquereux, L.,	..	×	×	×	×	×	×	×	×	×	..	×	×
*Lewis, H. C.,	..	..	..	..	..	..	×	×	..	..	..	..	..
Lyman, B. S., (6)	..	..	..	..	..	..	..	..	..	..	×	..	..
Mansfield, I. F., (7)	..	..	..	×	..	..	..	..	..	..	..	..	..
*McCreath, A. S.,	×	×	×	×	×	×	×	×	×	×	..	..	..

PERSONS ENGAGED IN THE SURVEY—*Continued.*

	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
McCreath, D.,	..	..	×	×	..	..	..	..	..	..	..	..	..
Merkle, J. F.,	..	..	..	..	..	..	..	..	..	..	..	×	..
Miner, Charles,	..	..	..	..	..	..	..	..	..	..	×	..	..
Morris, G.,	..	..	..	..	..	..	×	×	..	..	..	..	..
Moyer, H. I.,	..	..	..	..	..	..	×	×	×	×	..	..	..
Nettleton, E. S., (8)	..	..	..	×	..	..	..	..	..	..	..	..	..
Parrish, H. E.,	..	..	..	..	..	..	..	×	×	×	..	..	..
*Platt, Franklin,	×	×	×	×	×	×	×	×	..	..	..	..	..
*Platt, W. G.,	..	×	×	×	×	×	×	×	..	..	..	..	..
*Prime, F., Jr.,	×	×	×	×	×	×	×	..	..	..	..	..	..
Randall, F. A., (9)	..	..	..	..	..	×	..	..	..	..	..	..	..
*Sadtler, S. P.,	..	×	×	..	×	..	..	..	..	..	..	..	..
*Sauders, R. H.,	×	×	×	×	×	×	×	×	×	..	..	..	..
Scott, C. B.,	..	..	..	..	..	..	..	×	×	×	×	..	..
*Sheafer, A. W.,	..	..	..	..	..	×	×	×	×	..	..	..	..
*Sherwood, A.,	..	×	×	×	×	..	..	..	..	..	..	..	..
Simpson, G. B., (10)	..	..	..	..	..	..	..	..	..	..	..	..	..
Sims, H. N.,	..	..	..	..	..	..	..	..	×	×	×	×	..
Smedley, J. H., (11)	..	..	..	..	..	..	..	×	..	..	..	..	..
Smith, A. D. W.,	..	..	..	..	..	..	..	..	..	×	×	×	..
Somerville, B.,	..	..	..	..	..	..	..	..	..	..	..	×	..
Stinson, J. M.,	×	×	×	×	×	×	×	×	×	×	..	..	..
*Stevenson, J. J.,	..	×	×	×	×	..	..	×	×	..	..	..	..
Stockton, N. A.,	..	..	..	..	..	×	..	..	..	..	..	..	..
*Wall, J. S.,	..	..	..	..	..	..	..	..	..	..	×	..	..
Wells, Bard,	..	..	..	..	..	..	..	×	×	×	×	×	..
*White, I. C.,	..	×	×	×	×	×	×	×	×	×	×	..	..
Williams, T. J.,	..	..	..	..	..	..	..	..	..	×	×	..	..
Winslow, A.,	..	..	..	..	..	..	..	..	×	×	×	..	..
*Wright, G. F., (12)	..	..	..	..	..	..	..	..	×	..	..	..	..
*Wrigley, H. E., (13)	×	×	..	..	..	..	..	..	..	..	..	..	..
Young, C. A.,	×	×	×	..	..	..	..	..	..	..	..	..	..

(1) Special draughtsman for parts of two years.
(2) Special draughtsman for part of a year, (Fossils.)
(3) Special report on fossils of Centre county.
(4) Special report E.
(5) Special assistance in indexing several reports.
(6) Special survey along the Connodogwinit creek.
(7) Special collection of coal-plants.
(8) Special oil-well records.
(9) Special report on Warren section and fossils.
(10) Special draughtsman, (Fossils.)
(11) Special notes on Serpentine localities.
(12) Special survey of parts of the Glacial Moraine.
(13) Special report J.

*Authors of parts of reports.

The publications of the Survey have been—
1875, six volumes, B, D, H, I, J, M.
1876, four volumes, A, C, K, L, and a pamphlet B^2.

1877, five volumes, C^2, H^2, H^3, I^2, K^2.

1878, nine volumes, D^2, E, F, G, H^4, K^3, N, O, Q.

1879, three volumes, M^2, Q^2, V.

1880, twelve volumes, C^3, G^2, G^3, G^4, H^5, I^3, O^2, Pi, ii, P^2, Q^3, R, V^2.

1881, six volumes, A^2, G^5, H^6, M^3, Q^4, T.

1882, three volumes, C^6, G^6, T^2, and atlas (AA)1.

1883, seven volumes, AA, AC, C^4, D^3 (1), D^3 (2i), G^7, I^4, and atlas D^5.

1884, six volumes, H^7, K^4, Piii, P^3, T^4, Z, and atlas (AA)2.

1885, six volumes, AA^2i, C^5, F^2, R^2, T^3, X and atlases (AA)3 (AA)4.

1886, one volume, annual report of 1885, with a volume atlas of illustrations.

In twelve years the Survey has published 68 volumes 8° and one pamphlet, 4 anthracite atlases, and 9 other atlases to volumes AC, C^3, D^3, D^5, I^3, P, R, R^2, and T.

It has published *colored geological maps* of 57 out of the 67 counties. Colored maps of Cambria, Somerset, Juniata, Mifflin, Snyder, Union, Schuylkill, Berks, Montgomery, and Bucks being still unpublished; but *uncolored* geological maps of Cambria and Somerset are included in their volumes; and *colored* maps of the eastern half of Berks and of the southern parts of Montgomery and Bucks have been published in advance. All the county maps are on the scale of 2 miles to the inch, except McKean county and Philadelphia, which are on a scale of $1\frac{1}{2}$ miles to the inch. Colored geological maps of all the counties, on a scale of 6 miles to the inch, prepared by the State Geologist at various stages of the Survey, will be found in the Hand Atlas (X) published in 1885.

All the volumes of reports, with three or four exceptions, are illustrated with diagrams, sections (columnar and horizontal,) sketches made in the field, local maps, and photographic views of such important outcrops as could not otherwise be described with requisite accuracy, amounting in all to several thousand.

The distributions of the publications of the Survey, by the Board of Commissioners, was regulated for ten years—

that is, from 1875 to 1885—by section 10 of the act of May 14, 1874, which ordered that copies should be donated to all public libraries, universities, and colleges in the State, and should be furnished *at cost of publication* to other applicants; the money received therefor being covered back into the State Treasury.

It was supposed that, by this proviso of the act, every citizen of the State who really valued a report would be easily able to obtain a copy, while no copies would be wasted, as by a free distribution. But, in point of fact, there was little or no sale, because citizens of the State were accustomed to obtain from their Representatives and Senators, without cost, all other State documents.

Consequently, when, in 1875, Report B, on the Mineralogy of the State, and Report J, on Petroleum, appeared, and a popular demand for copies of them was made on the members of the Legislature, who could not furnish to their constituents what they had to purchase for themselves, an act was passed providing for *a special edition* of 5,000 copies of each one of these reports, for the use of the Senate and House of Representatives. Similar acts were subsequently passed by the Legislatures of 1877, 1878, and 1879, respecting all the reports.

Under these acts, 425,931 copies of Geological Reports were printed for members of the Legislature and distributed by them among their constituency.

In addition to this, and under the organic law of the Survey, the Board published 110,569 copies, part of which were distributed to public libraries, universities and colleges in the State, and the remainder held for sale at cost. But the sale of reports was almost wholly stopped by the free distribution of the special Legislative editions; so that in 1885 there still remained unsold 43,118 copies.

In view of this fact, an act was passed and approved by the Governor, July 3, 1885, the first section of which enacted:

"That the Board of Commissioners of the Geological Survey are hereby authorized and directed to distribute the remaining copies of said reports as follows: Fifty copies of each report to the State Librarian for distribution and exchange with other States and Territories, and of the balance an equal num-

ber of volumes to each member of the present Senate and House of Representatives, making the sets complete as far as practicable."

The Board, before acting under this law, submitted the same to the Attorney General of the State, and in accordance with the interpretation of the act received from the Department, the stock of reports was distributed as follows:

Copies retained for distribution to public libraries, universities and colleges in the State, under the act of May 14, 1874,	6,132
Copies (50 sets) delivered to the State Librarian,	3,600
Copies delivered to the Senate Librarian for distribution to the Senate,	7,040
Copies delivered to the Resident Clerk of the House of Representatives, for distribution to the members of the House,	26,162
Copies mislaid and discovered after distribution had been made,	61
Copies damaged,	123
Total,	43,118

The handling, recording, and distributing of so large a stock of publications, in a satisfactory manner, entailed a serious amount of time, labor, and expense, but it was all accomplished by the first of December.

The Board of Commissioners have now no reports on sale, as formerly, nor any copies for free distribution. But to meet necessary demands, copies will be purchased as occasions offer, and will be sold to applicants at cost of publication.

The future publication of reports is regulated by section 2 of the act of July 3, 1885, which reads as follows:

"That of each report hereafter published, three thousand five hundred copies shall be printed, which shall be distributed by the Board of Commissioners as follows: Five hundred copies to the Senate, two thousand copies to the House of Representatives, one hundred and fifty copies to the State Geologist, out of which he shall donate copies to authors and to members of Survey corps as heretofore granted, six hundred copies to the Board of Commissioners for distribution to public libraries, universities, and colleges in the State, to parties rendering material assistance to the Survey and for exchange with foreign societies and geologists, and fifty copies thereof to the members of the Board, one hundred copies to the Secretary of Internal Affairs, for distribution by him, one hundred copies to the Governor for distribution by him, and fifty copies to the State Librarian, for distribution and exchange with other States and Territories."

In consequence of this enactment, citizens of the State must apply to their Representatives at Harrisburg for copies of this Annual Report of 1885, as well as for any future publications of the Geological Survey which they may desire to own.

Progress in 1885.

From the first of January to July 3, when the act of Assembly was approved by the Governor, the work of the Survey was limited to office work on the maps and sections of the anthracite region, verifying, correcting, and supplementing the data on which they were based by the necessary amount of field work and underground examination.

As soon as the continuance of the survey was assured, arrangements were made for resuming work in western Pennsylvania. Mr. Carll and Mr. d'Invilliers were recommissioned and took the field; the former to report on the gas-wells especially; the latter to report on the coal-beds of the Pittsburgh district. Part of the season Mr. d'Invilliers was directed to make a special survey of the Cornwall mine in Lebanon county.

Mr. E. B. Harden made a special survey of the Mt. Savage fire-clay mines in Somerset county.

Mr. Ashburner found time, in addition to that required for the discharge of his special duties as Geologist in charge of the Anthracite Survey and of the executive work of the entire Survey, to make a special study of the Tipton coal-beds in Blair county, and another of the kaolin beds in Delaware county.

Mr. Hill, as assistant geologist, has assisted Mr. Ashburner in continuing and extending the Anthracite Survey, aided by Messrs. O. B. Harden, George M. Lehman, and A. D. W. Smith. Mr. Hill has rendered other efficient help connected with the general work of the Survey.

During the field season Messrs. J. F. Merkle and Bond Somerville were employed as volunteer aids on the anthracite work.

Mr. Baird Halberstadt has been engaged on accounts and general office work at headquarters, Mr. Adachi on draughting work, and Mr. H. F. Albright on general clerical work.

The curtailment by the Legislature of the appropriation of $90,000 asked by the Board for 1885 and 1886 to $50,000, made it necessary to reduce the size of the corps, and Messrs. Wells, Branner, Sims, and Scott resigned their positions to form more lucrative connections. All these gentlemen were experienced in their special work, and their loss to the Survey was great.

In the first half of the year I was occupied with the publication of such volumes of reports as appeared in the course of the year; that on Huntingdon county especially consuming much time. From July onward I was engaged in preparing a summary of the Geology of Pennsylvania for popular use. The call for such a work has been general throughout the State. Until now I have been unable to prepare it, owing to incessant demands made upon my attention. To relieve me of these interruptions, the Board approved of my delegating the executive business of the Survey to Mr. Ashburner, who was placed in charge of correspondence, publications and accounts, with a general oversight of field and office work.

The Survey of the Oil Regions, by Mr. John F. Carll, had special reference to the recent application of rock-gas to the iron and glass industries of the Pittsburgh district, and to the lighting and heating of houses, factories, and streets. His preliminary report appeared in the Annual Report for 1885.

A sixth chapter was appended to Mr. Carll's report, entitled, *Notes on Recent Oil-borings in Potter county*, in which Mr. Ashburner shows by their records that No. 1 well, which is only 2029′ deep, actually goes 169′ deeper into the measures than well No. 3, which is 2750′ deep, and goes 294′ deeper into the measures than well No. 4, which is 2100′ deep. It is an excellent lesson in oil geology. It shows, also, how properly kept well-records can be used for discovering the true dip at great depths (see page 94,) and it indicates the probability that the Bradford Oil-sands of McKean do not extend eastward through Potter county.

A discussion of the *possible quantity, pressure and fuel-value of the rock-gas* was also included in the volume.

Also Mr. d'Invilliers' *preliminary report* of his *Survey of the Pittsburgh Coal* region, respecting the underground structure of the area included between the Youghiogheny and Allegheny rivers; with maps showing the basining of the Pittsburgh coal-bed, and the irregular shape of the anticlinals.

Mr. Leo Lesquereux's active employment on the Survey terminated in 1883, when the services of the chemist at Harrisburg, and the mineralogist at Philadelphia were also suspended; but he was employed to write, specially for the Annual Report of 1885, a concise statement of the grounds upon which geologists base the now universally accepted theory of the *vegetable origin of coal-beds*. It is to his researches, in early life, into the nature and growth of the European peat-bogs, that we owe the complete demonstration of the theory, of which a direct study of coal-beds can furnish only circumstantial evidence.

A paper on the *Subcarboniferous limestone* struck in the Washington county well, was communicated for the Annual Report by Professors Linn and Linton.

It included also a report on the *Wellersburg coal basin*, by the late Commissioner, James Macfarlane; and on the fire-clay mines, by Mr. E. B. Harden; and another on the Tipton coal mines, by Mr. Ashburner.

Mr. Ashburner's report on the *Progress of the Anthracite Survey*, shows that it was carried on continuously, with a diminished number of assistants; its operations being confined to the Western-Middle and Northern fields. No work was done in the Pottsville, Mine Hill, and Hazleton basins. A large amount of field and office work was accomplished, and a great mass of new data obtained, the discussion and verification of which for publication in topographical sheets, mine sheets, columnar section sheets, and cross section sheets, has occupied the whole of 1886 and part of 1887. Had the estimates of the State Geologist in the report of the Board to the Legislature been accepted as a practical basis for the appropriation, the corps in the Anthracite region would have been kept up to its standard size, and the amount of work doubled; the Survey of the Eastern

Middle field would have been finished; and that of the Southern field extended from Tamaqua to Pottsville. The topographical survey of the Lackawanna basin would have been finished, and that of the Pottsville basin well under way. As it is, neither of these important parts of the work can be undertaken until the Legislature provides for the expense.

Mr. Ashburner's special report on the *fossiliferous limestones in the anthracite coal measures* of the Wyoming valley includes Prof. Heilprin's figures and descriptions of the *fossils*;—also a report by Mr. Ashburner on the *pot-holes* near Scranton, and at Nanticoke, the scene of the December disaster, with maps of the localities;—also Mr. Hill's report on the side-limits of the old *buried valley of the Susquehanna* from Pittston to Wilkes-Barre, showing how desirable it is for the owners of collieries to carry on systematic boring ahead of their workings;—also a report on the *Bernice coal basin* in Sullivan county, with an elaborate topographical map by Mr. E. B. Harden.

The report on the *Cornwall ore mine* was written by Mr. E. V. d'Invilliers and myself conjointly, on the basis of his field surveys and my subsequent observations at the mine. His map of the present form of the workings was inserted in the body of an excellent old survey map by Mr. W. F. Shunk. The two models, of which photographic views are given, were made, one by Mr. E. B. Harden, the other by Mr. A. E. Lehman.

To the report on the *Kaolin deposits of Delaware county* by Mr. Ashburner, I added a discussion of the probable origin of the mineral.

Prof. Merriman's report on the *progress of the U. S. triangulation in Pennsylvania*, with a map, shows that points of primary triangles have been established over about one third of the State. This work of the United States Government advances slowly in the several States, because the States themselves do not lend it any assistance, in spite of the fact that no good map of any State, county, or township can be constructed until points of reference have been established by triangulation.

During the progress of our Geological Survey from 1874 to 1883, numerous special topographical surveys were made in sections of the State where such surveys were absolutely required in order to correctly explain the geological structure. In this way about 4,000 square miles of the State were mapped; but, on account of the restricted appropriations for the four succeeding years, the topographical work of the Survey has been restricted to portions of the anthracite region; and to the completion of the South Mountain map by Mr. Lehman.

This has prevented the publication of a nearly completed topographical map of Southern Indiana and Northern Westmoreland counties, between Johnstown and Pittsburgh. The topographical map of the South mountain should be extended southward further into York county, and north-westward so as to cover the limestone and iron ore belt of the Cumberland valley, as was done in Northampton, Lehigh, and Berks counties, and the two great maps should be connected by a belt of special surveys from Reading to Dillsburg, in York county. The limestone area west of Reading requires a great deal of special surveying.

The geology of Delaware and Chester counties will never be understood until every outcrop in the region is carefully located, the relief of the hills and valleys measured, and a detailed topographical map constructed.

Materials for a permanent geological map of the State have been collected during the course of the Survey, but we have no good topographical base for such a map.

The best map of the State which is now in existence is based upon a map made by authority of the Legislature, by an act approved the 19th day of March, 1816. This was known as Melish's State map, and it has furnished the frame-work of all subsequent maps of the State which have been constructed. Not a single county in the State is correctly mapped. In constructing a State map, these county maps might be combined, but, as they are all incorrect, they will not fit together.

Nothing but a topographical survey of the State, which will establish a true position of every point on its surface

north and south, and east and west, from every other point, and the elevation of every point on its surface above tide, will furnish its citizens with correct maps of their respective counties and townships, on which the county surveyors can then place the land lines, and geologists and mining engineers the mineral areas and outcrops. For a State so rich in minerals, this is a need of the first importance, and calls for it have been made from every quarter of the State.*

The topographical maps of special areas already completed by the Geological Survey for geological purposes make a large contribution of accurate maps toward a general topographical survey of the State, which would, in fact, be only a continuation of the work of the Geological Survey.

The United States Coast and Geodetic Survey, under authority of Congress, which permits them to assist State Surveys, is now making a triangulation survey of the State and obtaining the true longitude and latitude of prominent points in the State, so that this work will form a valuable and necessary basis for the topographical mapping which should now be undertaken by the Geological Survey. Some of the errors on the best State and county maps which are now in existence, which have been detected by the work of the United States Coast Survey, are very large.

To continue the topographical surveys already begun and to commence a topographical map of the State, which shall be published on a scale of one mile to one inch, an annual appropriation of at least $10,000 will be required.

The United States Surveys, acting under authority of Congress, in the latter part of 1884, made the following propositions to the Board of Commissioners, the acceptance of which by the Board depended upon the appropriation for the State Survey being secured.

(1) The Director of the United States Geological Survey offered to coöperate with the State Survey in the topo-

*See proceedings of Convention of County Surveyors in Harrisburg, October, 1880, and the annual report of 1883, of Hon. J. Simpson Africa, Secretary of Internal Affairs.

graphical mapping, and to expend in the State $30,000 annually.

(2) The Superintendent of the United States Coast and Geodetic Survey offered to coöperate with the State Survey, and expend in the State $5,000 annually, in order to push more vigorously the triangulation of the State, which must of necessity precede the topographical work.

The Board of Commissioners therefore recommended to the Legislature of 1885 that an appropriation of $10,000 a year for 2 years should be made. Had that appropriation been made, it would have effected an actual annual expenditure for this purpose of $45,000 by the three Surveys (State Geological Survey, $10,000; U. S. Geological Survey, $30,000; U. S. Coast and Geodetic Survey, $5,000) in extending the triangulation and the topographical mapping of the State, which has been slowly progressing for the past ten years; the triangulation work under the Coast Survey, and the topographical work under the State Survey.

It is estimated that this mapping of the State will cost $500,000, which would require the State Survey, unaided, fifty years to complete, with an annual expenditure of $10,000. Such a survey of New Jersey is now nearly completed; and one of Massachusetts, partly paid for by that State, is now in progress.

Progress in 1886.

The surveys of Mr. Carll and Mr. d'Invilliers in the Pittsburgh region, begun in 1885, have been continued in 1886, and their several reports on Oil, Gas, and Coal are going through the press for the Annual Report Volume of 1886, illustrated with maps, sections and diagrams.

A revision of the iron deposits of the Cumberland and Lebanon valleys was made; the report on which will appear in the volume exhibiting the work accomplished during 1887.

The field and office work of the survey of the Anthracite region, under the direction of Chas. A. Ashburner and Frank A. Hill, has been carried on throughout the year without intermission.

The fossil plant collections have been labeled, catalogued, boxed and stored ; and the large collection of fossil shells from Middle Pennsylvania has been arranged for study and partly labeled.

My Summary Report of the Geology of Pennsylvania has fully occupied me the entire year and will be soon ready for the press.

J. P. Lesley,
State Geologist.